What is Claimed

1. A method for enhancing the surface hardness and smoothness of cobalt-chromium alloys through exposure in a reaction vessel to a mixture of reaction gases at a partial pressure (less than atmospheric) within a temperature range of 250°C to 1000°C for process time sufficient to create a substantial compound layer.

2. The method of claim 1 wherein the reaction vessel utilizes a pulse plasma glow discharge as a media for the reaction.

3. The method of claim 1 wherein the total pressure of reaction gases is 0.5 to 100 mbars.

4. The method of claim 1 where the temperature is 400°C to 600°C

5. The method of claim 1 wherein the reaction gases are Ar, N_2, H_2.

6. The method of claim 3 wherein the reaction gases are Ar, N_2, H_2.

7. The method of claim 1 wherein the reaction gases are Ar, N_2, H_2, CH_4.

8. The method of claim 3 wherein the reaction gases are Ar, N_2, H_2, CH_4.

9. The method of claim 1 wherein the reaction time is 6 – 42 hours

10. The method of claim 1 wherein the reaction the reaction time is approximately 24 hours.

11. The method of claim 1 where the pulse pause ratio is 1:0 to 1:50.

12. The method of claim 3 where the pulse pause ration is 5:1 to 1:20.

13. The method in claim 1 in which the identified hardened surface contains a compound layer of Cr-N of 1 to 20 microns thickness.

14. The method in claim 1 in which the identified hardened surface contains a compound layer of Cr-N of 3 to 15 microns thickness.

15. A method for enhancing the surface hardness and smoothness of a cobalt chromium material and with surface hardness and smoothness improved through exposure in a reaction vessel to a mixture of reaction gases (Ar, N_2, H_2, CH_4) for process time sufficient to create a compound layer substantially comprised of chromium nitrides.

16. The method of claim 15 wherein the reaction gases are Ar, N_2, H_2.

17. The method of claim 15 wherein the reaction gases are Ar, N_2, H_2, CH_4.

18. The method of claim 15 wherein the said material is ASTM F-75 and ASTM F-75 Modified alloy

19. The method of claim 15 wherein the process temperature is held between 400°C to 600°C.

20. The method of claim 15 wherein the process partial pressure is held at less than atmospheric.

21. The method of claim 15 wherein the process partial pressure is held at approximately 1-10 mbars.

22. The method of claim 15 wherein the said cobalt chromium alloy is ASTM F-799, F75, and F75 modified.

23. A method for enhancing the surface hardness and smoothness of a cobalt chromium molybdenum base material and with surface hardness and smoothness improved through exposure in a reaction vessel incorporating pulse plasma of reaction gases varies in on-to-off process levels.

24. The method of 15 and 24 where in the pulse plasma on-to-off ratio is 2:1 to 1:10.

25. The method of 1, 3, and 15 through exposure in a reaction vessel incorporating convection preheating.

26. The method of 1, 3, and 15 through exposure in a reaction vessel incorporating single and multi zone cooling

27. The method of 1, 3, and 15 through exposure in a reaction vessel incorporating a central anode.

28. The method of 1, 3, and 15 through in a reaction vessel wherein the parts are masked to prevent nitriding in unwanted areas.

29. The method of 1, 3, and 15 through exposure in a reaction vessel incorporating helium as a replacement carrier gas for the hydrogen.

30. The method of 1, 3, and 15 through exposure in a reaction vessel incorporating thermocouple temperature measurement of the parts.

31. The method of 1, 3, and 15 through exposure in a reaction vessel incorporating a sputter step to increase the surface reactivity of the workpiece.

32. The method of any one of claims 15 to 31 wherein the creation of a substantial nitrogen diffusion layer is avoided.

33. The method of claim 1 wherein the reaction vessel utilizes a plasma glow discharge as a media for the reaction.

34. The method of claim 1 wherein the reaction gas is nitrogen.

35. The method of claim 1 wherein the reaction gases are nitrogen and a carrier gas with optionally argon and optionally a carbon precursor.